Is the production of Natural Rubber from Hevea really threatened?

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The Future of Natural Rubber
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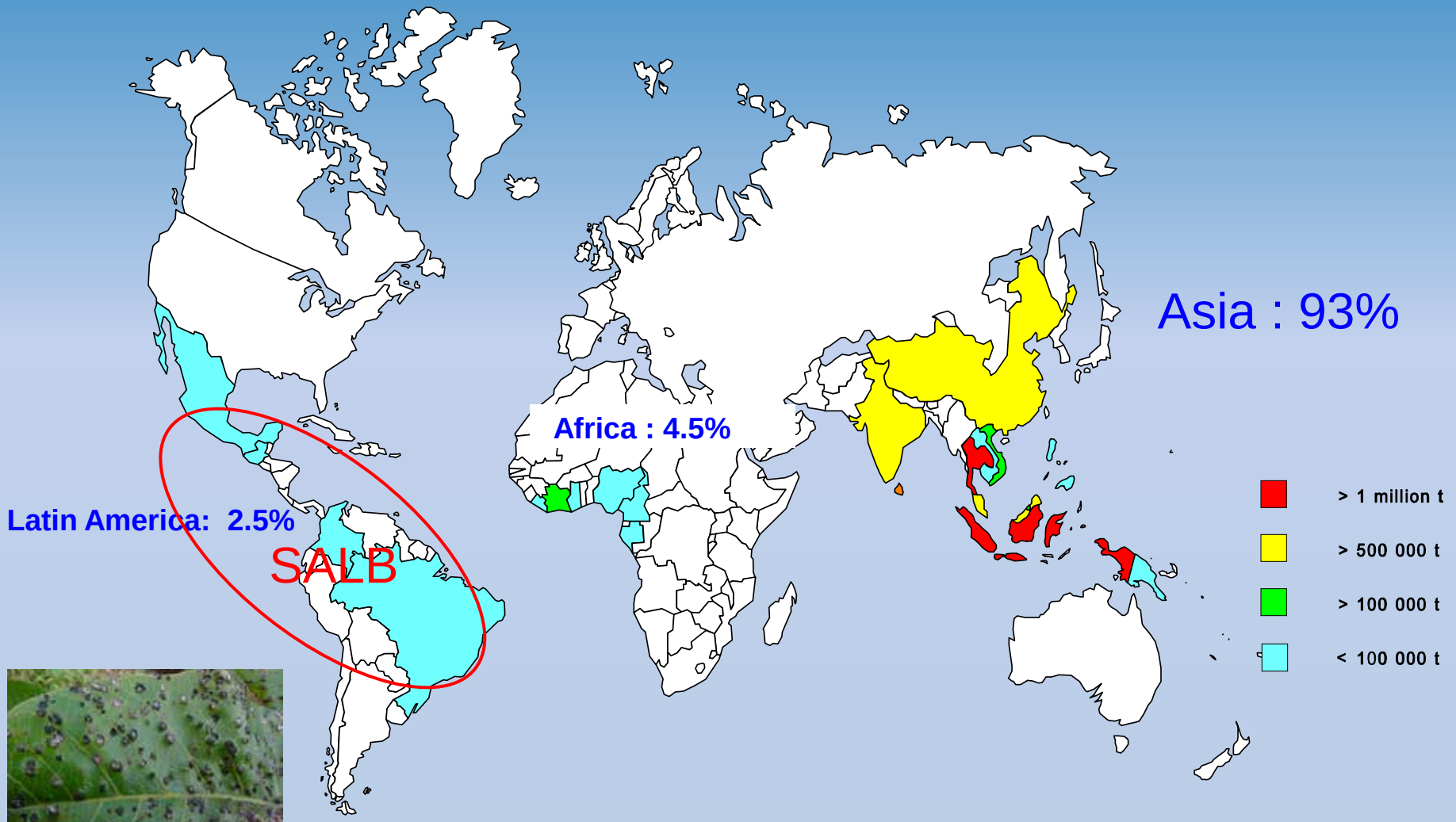
Natural Rubber Production

NR production in the world = 10 millions of tons, for 10 millions of ha

- Latin America produces only 2.5% of NR production,
- South American Leaf Blight (SALB) is responsible of this situation, representing the main obstacle of rubber tree development, because it's the most destructive disease of the rubber tree,
- When the disease pressure is high, SALB drastically limits natural rubber production in this continent,
- SALB is only present in Central and South America, from latitude 18°North to 24° South,
- Introduction of SALB in Asia or in Africa would be a disaster for 20 millions of producers.

Natural Rubber producing countries

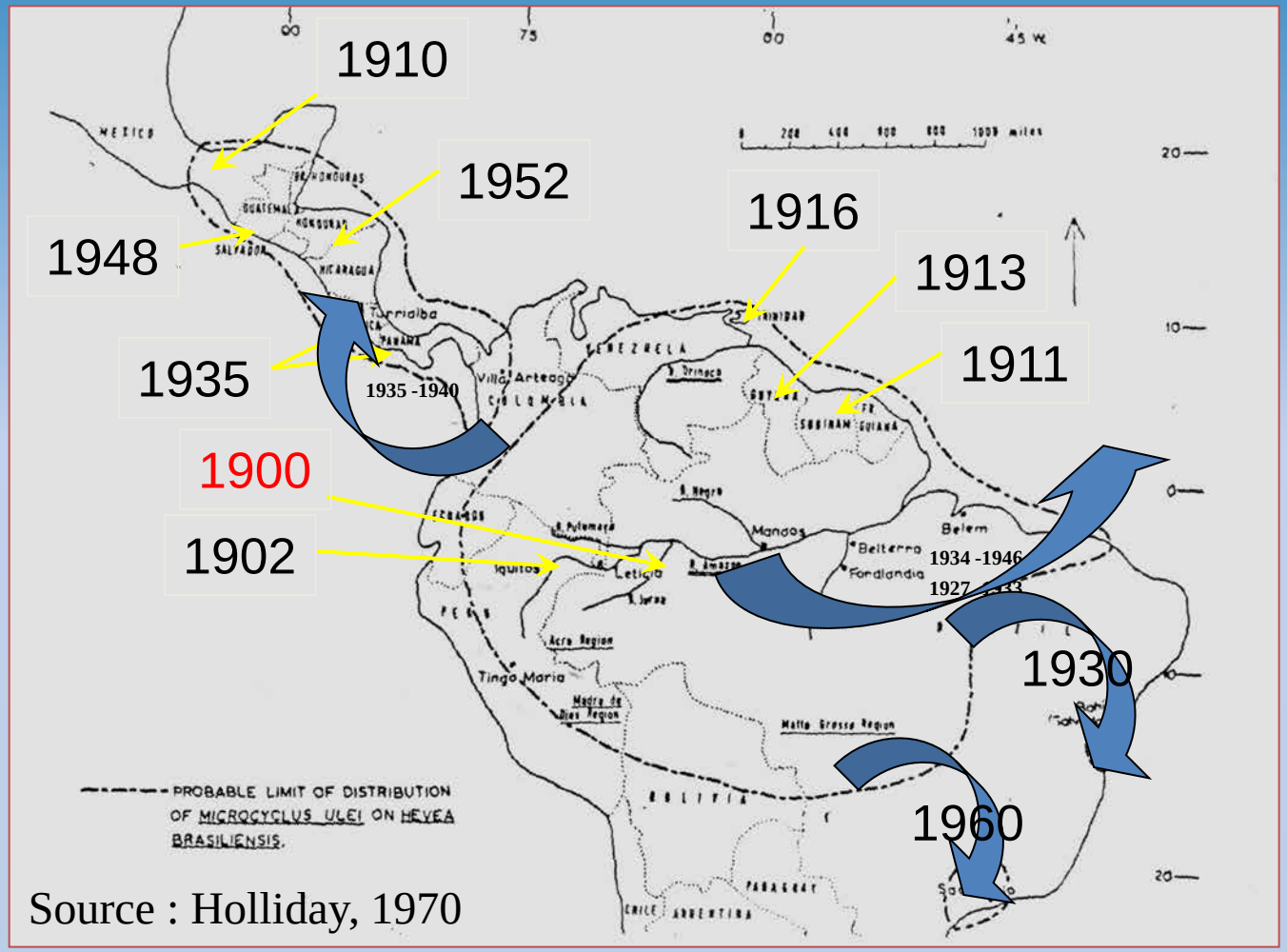


Sources : IRSG

Microcyclus ulei

- The fungus causes successively severe shedding of young leaves during rainy season,
- It weakens and even kills the trees,
- The rubber yield drops to 1 Ton/ha/year or less instead of 2 Tons/ha/year in normal conditions,
- Asian clones are highly susceptible: RRIM 600, GT1, PB 260, etc.

History : *Hevea spp. -Microcyclus ulei*



Future ?

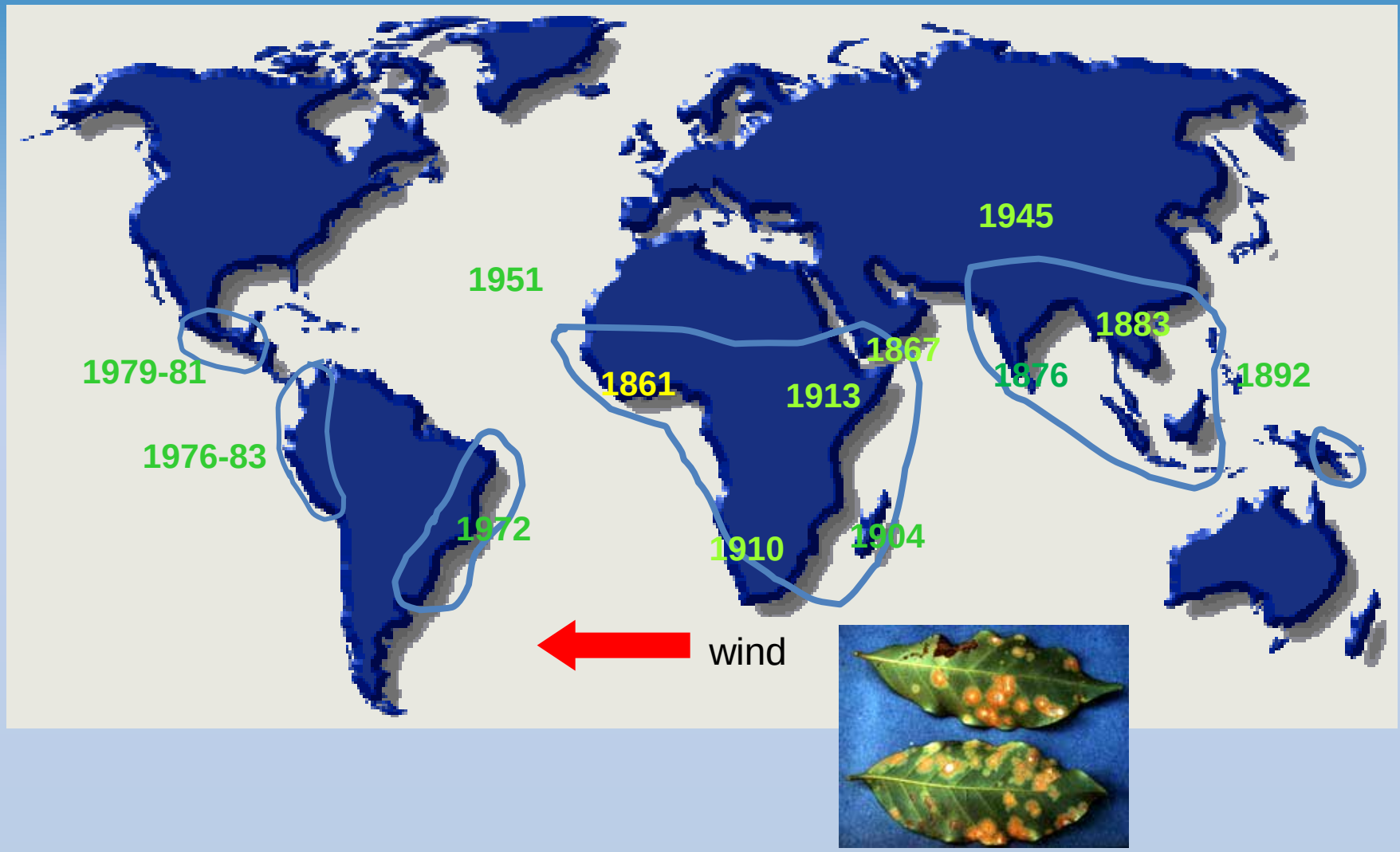
Risks of introduction of SALB in other continents?

§ Identified Pathways:

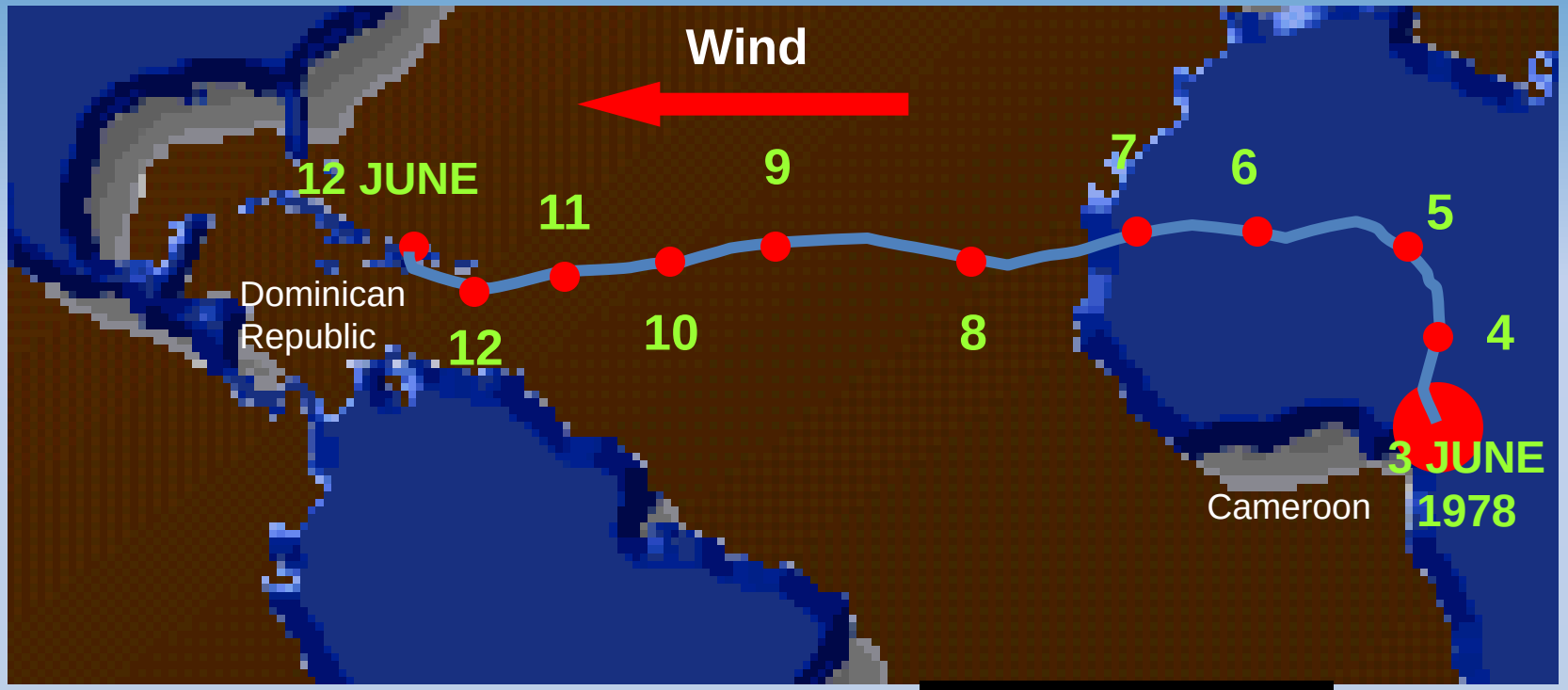
- ü Hosts: seeds, seedling, tissue culture, budwood/budded stump, fruit pods, dried leaves, herbarium specimen, decorating material, logs, brown bark, lumber, wood chips, sheet rubber and cup lump.
- ü Non host : plant materials,
- ü Non host products,
- ü Non plant materials (e.g. soil , stone),
- ü Conveyance / carrier

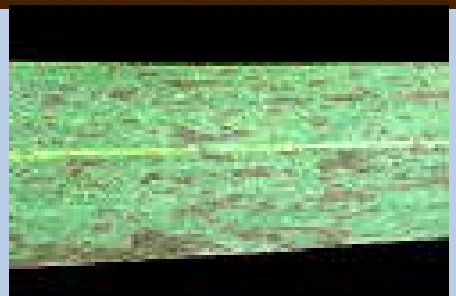
- The conclusion of the Pest Risk Analysis on SALB (meeting in China, august 2007) is that "the probability of establishment and spread within rubber growing areas should be considered **HIGH** if SALB is introduced into a suitable environment on appropriate host material."
- Examples of other diseases introduction…

Coffee Rust (*Hemileia vastatrix*)



Introduction of Sugarcane Rust into the Americas in 1978 (*Puccinia melanocephala*)





Disease Control Methods

Chemical control

- Good in nurseries, budwood garden, and young plantations,
- But it is costly, not sustainable, and not environmental friendly.

Agronomic control: 1/2
Crown budding

Advantages:

- Saving plantation of susceptible clones,
- Using «resistant » clones for crown,
- where the SALB pressure is high.

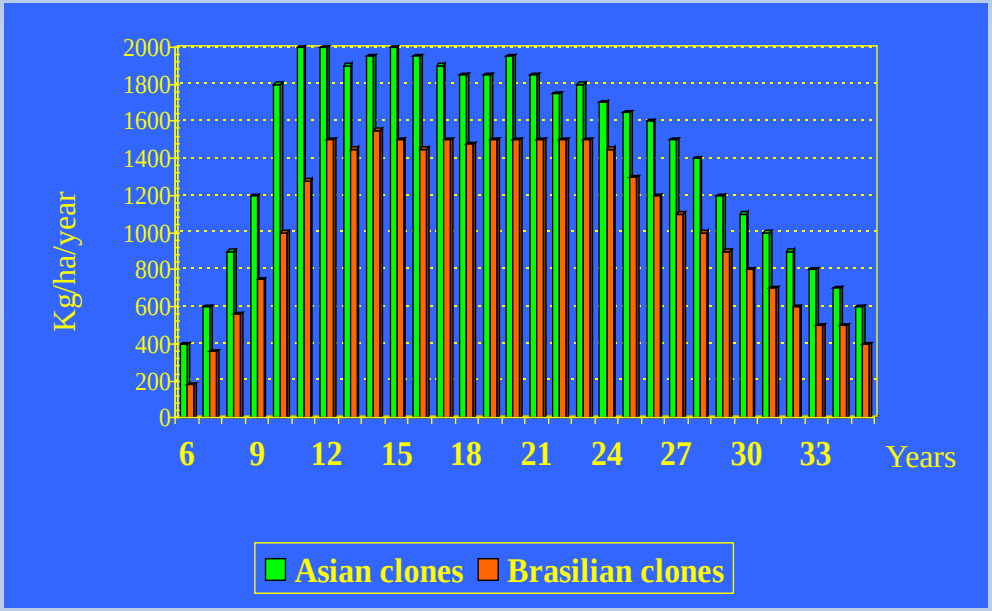
Disadvantages:

- High cost, difficulty to obtain 100% budded trees,
- Weakness of the crown because the incompatibility of trunk - crown,
- Negative effect on rubber production, if different species between trunk and crown,
- Vertical resistances are easily broken after a few years, there is no warranty of resistance sustainability.

Agronomic control: 2/2
Escape Areas

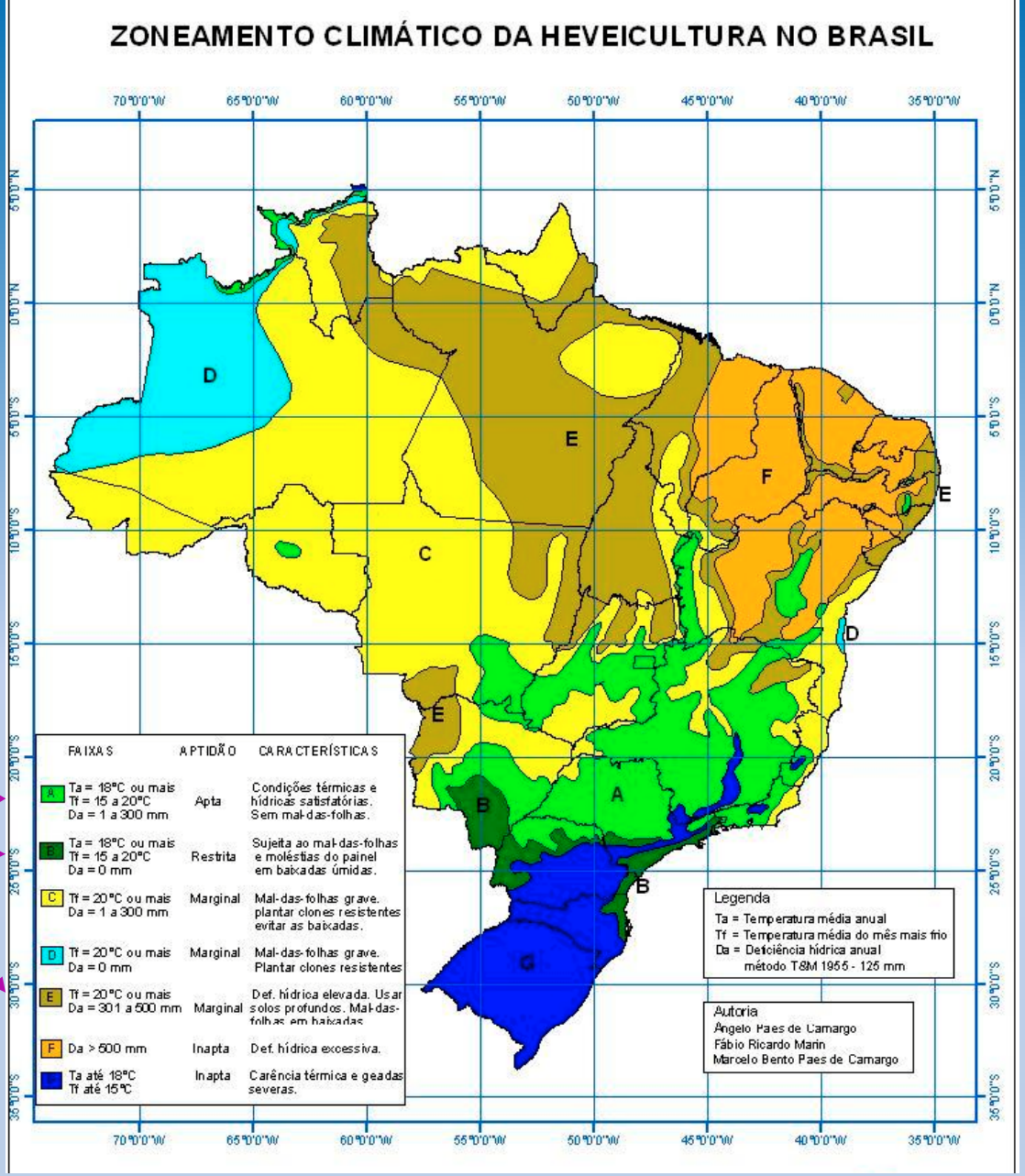
- Long dry season (4-5 months), defoliation and refoliation occurring during dry season, water deficit > 200 mm,
- Young leaves are not attacked during refoliation (with low RH),
- Asian clones (susceptible) are allowed in escape areas with security of higher yields (1.8 - 2 t/ha/year)

7 years GT1 plantation in Colombia



Camargo et al.

2003



Current rubber development

Escape areas were first identified in Brazil in 1981 (Ortolani et al.), then in Colombia (1997), Mexico (2000) and Ecuador (2006).

Escape area is "one but not the only" alternative

- Because it depends on …
  - Land availability and price,
  - Labor availability,
  - Competition with other food crops and cattle,
  - Limiting factors for production in sub-optimal areas: coldness, dryness, pests…

Plant Breeding is the promising way for a sustainable control of SALB

Since 1928, different companies participated in breeding for SALB resistance :

- 1945: Ford Motor Company planted 9'500 ha in Amazon valley in Brazil with Asian and native wild clones, but SALB epidemics forced the Ford Company to abandon the plantations to the Brazilian government: 1st failure,
- 1947 - 1983, Firestone started a Breeding Program for SALB resistance with other institutes in Latin America, but stopped and left the continent: 2nd failure,
- From these experiences , **few clones** issued and recommended for planting in Latin America, with low productivity and **broken resistance to SALB.**

- **1982: CIRAD** started a research program on SALB in **French Guiana,**
- **1980-1984 : Michelin** developed in **Brazil** new rubber plantations in:
  - Mato Grosso (Escape area)
  - Bahia (High SALB epidemic area)

1992: Cirad and Michelin unified their experience for a Cirad-Michelin-Brazil project (CMB) to create productive and SALB resistant clones, and clones adapted to sub-optimal areas.

CMB Project

The plantation of Michelin in Bahia is probably the most severely SALB affected plantation of Brazil we know. A very severe incidence of SALB is observed and the diversity of the pathogen is very complex: many virulences are present in this plantation with a high agressiveness of the isolates. In 2010, 64 different races have been identified among 159 isolates (C. Mattos).

Genetic ressources for SALB resistance

Wild or half-domesticated material (Germplasm = 1000 clones)

Wild genotypes
Very low yield
Sustainability of resistance was not verified **(r or Rs)**

Hybrid genotypes
Hight variability of yield
weak resistance **(r)**

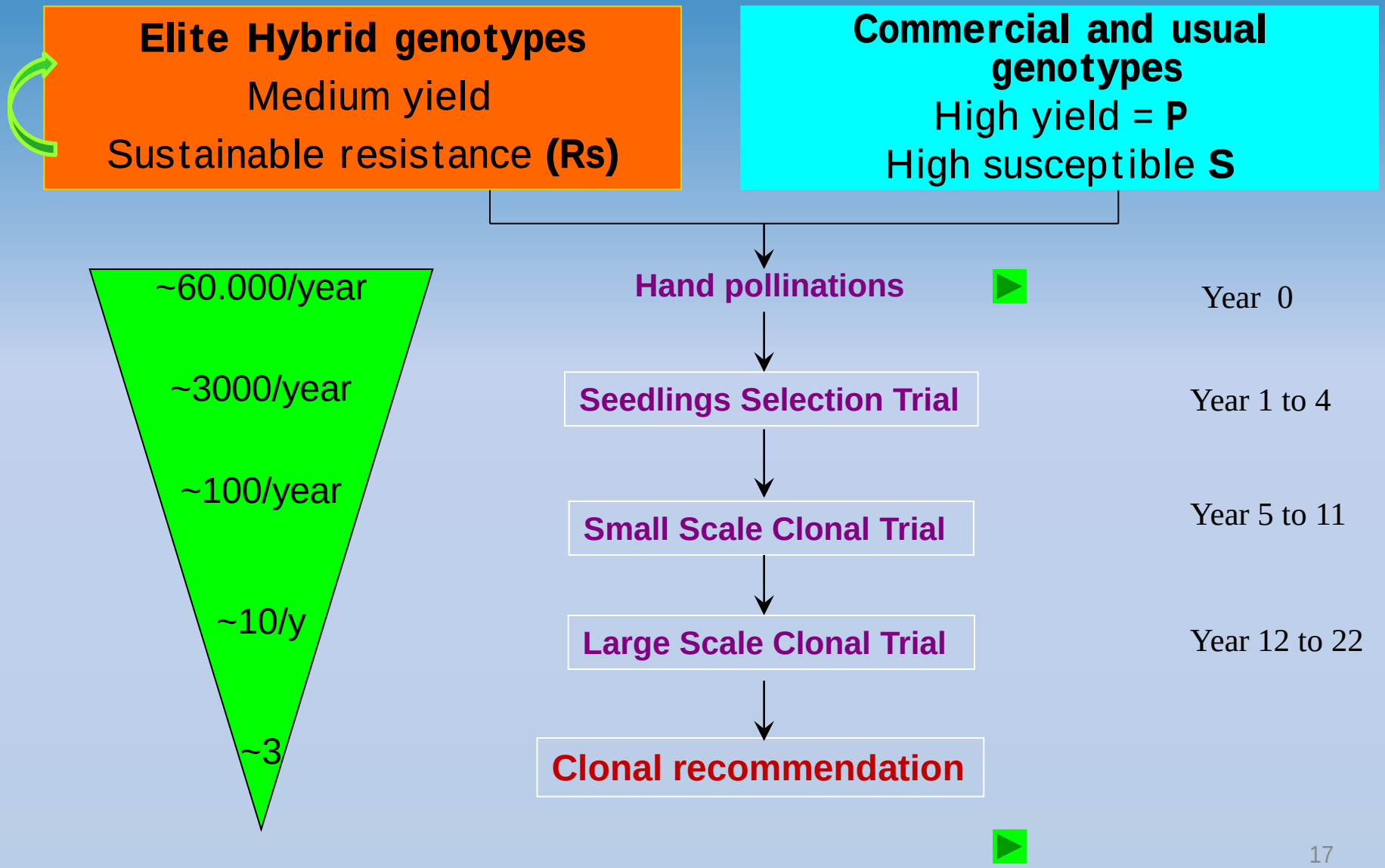
Elite Hybrid genotypes
Medium yield
Sustainable resistance **(Rs)**

Domesticated material

Commercial and usual genotypes

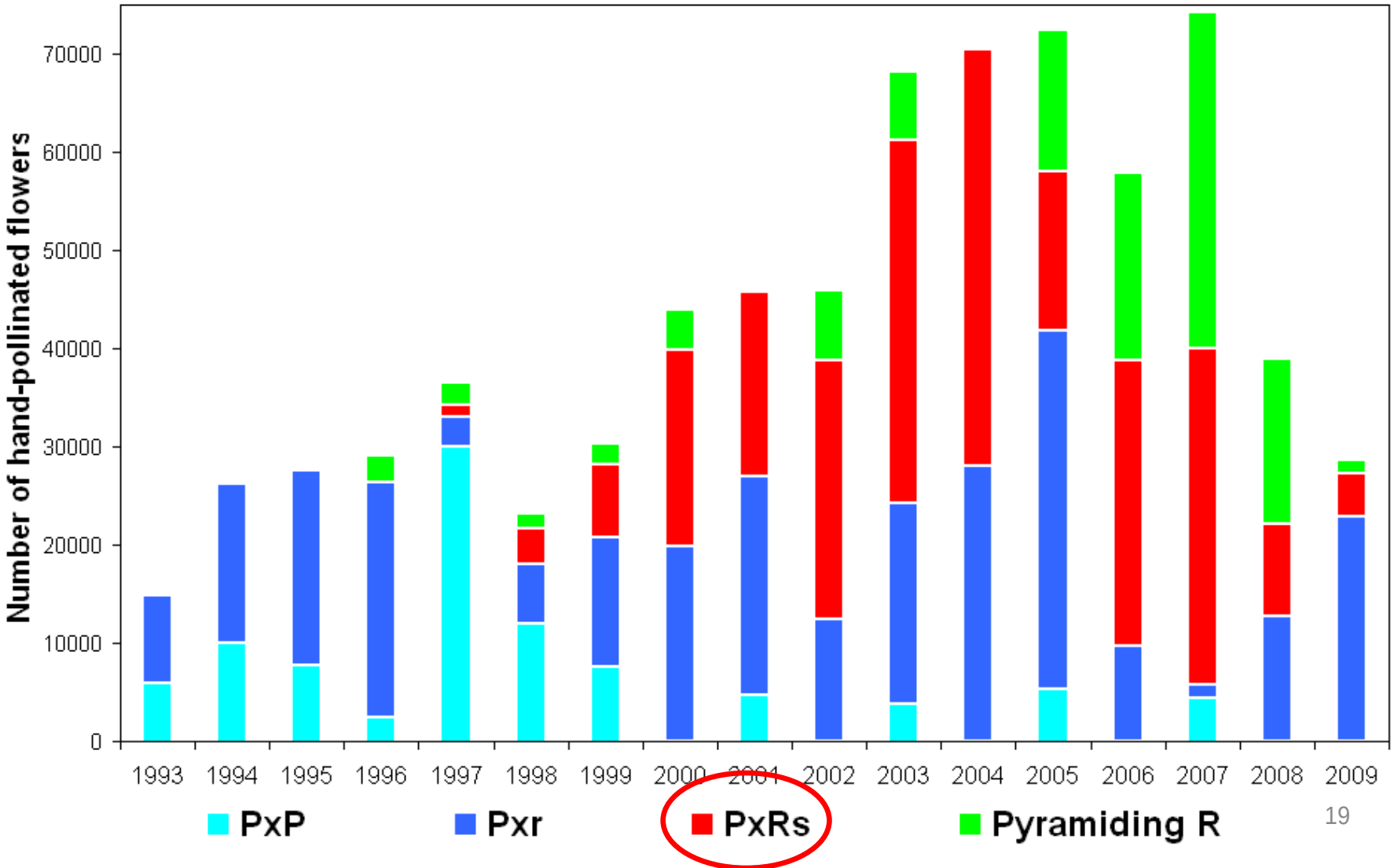
High yield = **P**
High susceptible **S**

SALB breeding program diagram

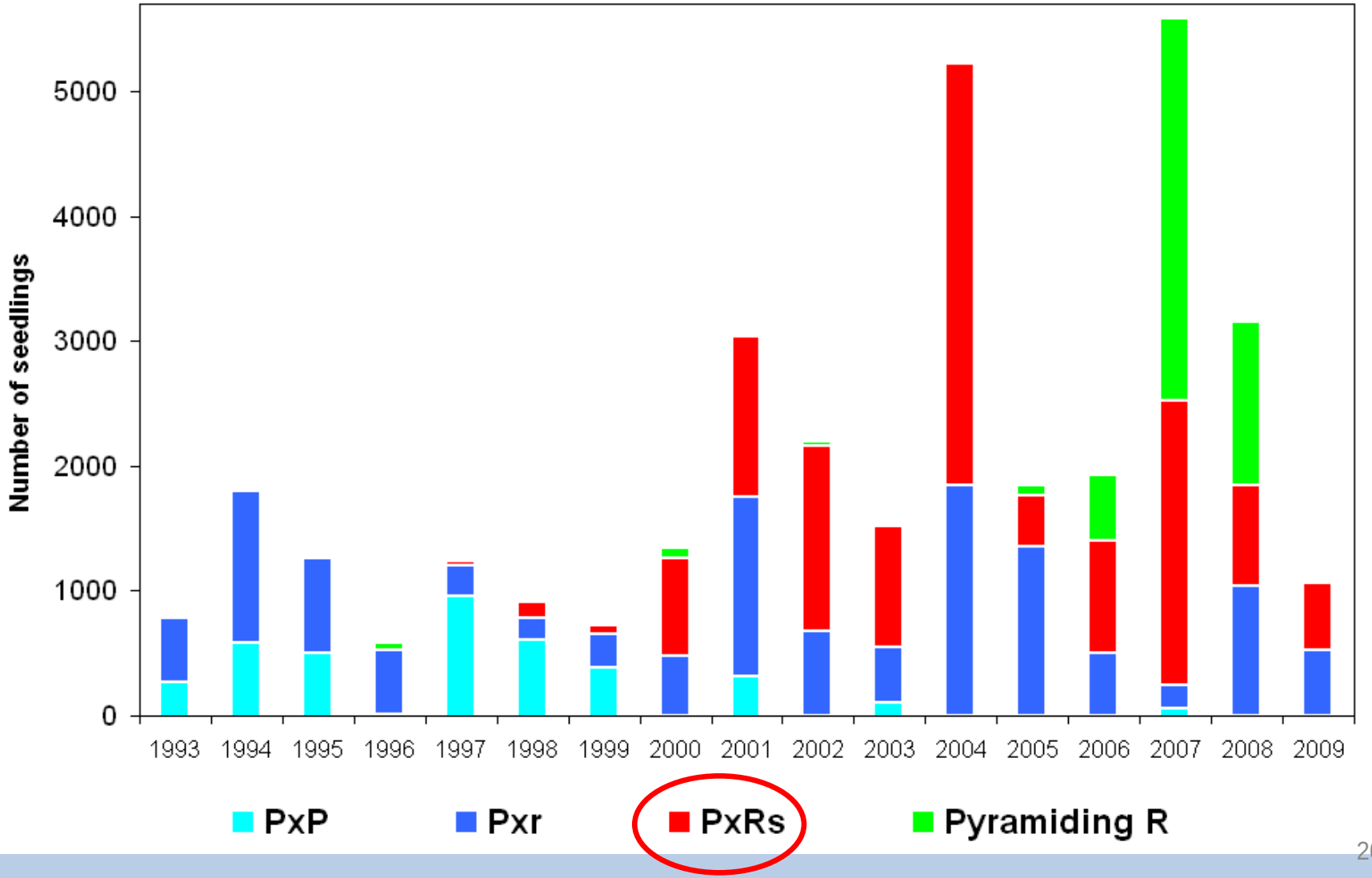


Hand pollination in rubber tree

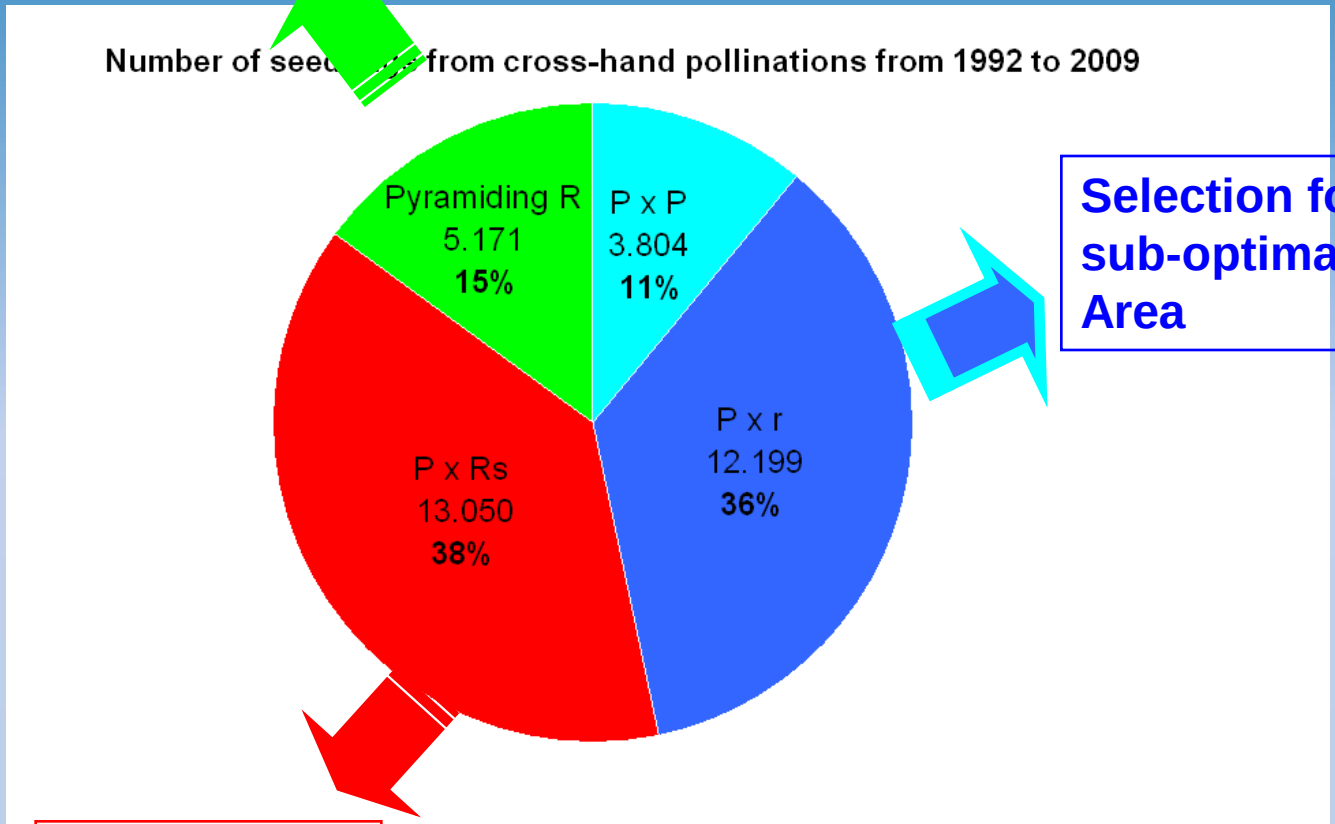
Development of pollinations for 17 years of the CMB breeding program



Number of seedlings produced from 1993 to 2009



Selection for next SALB resistant parents



Selection for sub-optimal Area

Selection for SALB area

CMB Breeding trials in 2010 (since 1992)

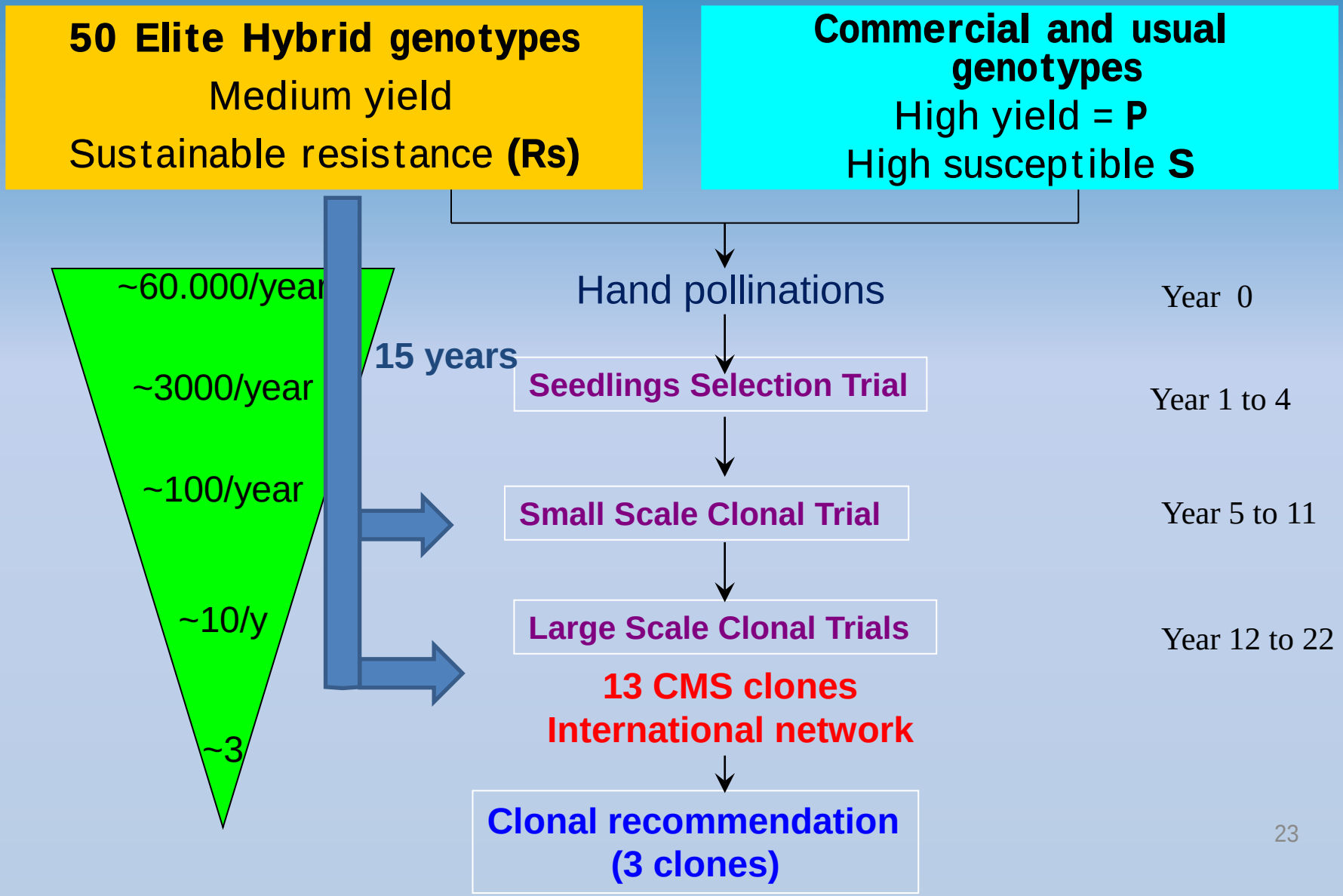
Trial	Number of trials	Area (ha)	Number of progenies	Number of genotypes	Number of clones	Number of selections /year
Seedling Selection Trials	18	16.4	302	**34.224**	-	
Small Scale Clone Trial	12	64.7	85	-	**1414**	100
Large Scale Clone Trial	2	18.3	-	-	**49**	10-15
Monoclonal Trial in 2010	1	15	-	-	**3**	3-4
Total	**33**	**115**				

Shortly

Variety protection (UPOV)

CMB clones development

SALB breeding program diagram



International network of 13 CMS Clones 1/2

13 resistant clones (13 CMS clones) with medium production were selected:

CD 1174	FDR 4575
CDC 56	FDR 5240
CDC 312	FDR 5283
MDX 607	FDR 5597
MDX 624	FDR 5665
PMB 1	FDR 5788
	FDR 5802

Inoculation *in vivo* of conidia of *Microcyclus ulei*

International network of LSCT with 13 CMS Clones (1/2)

1. Brazil: (7 trials)
   - Acre, Rio Branco : Embrapa(02/2008)
   - Mato Grosso, Itiquira: PEM (12/04-12/2007)
   - Rio de Janeiro, Silva Jardim: Pesagro (05/08)
   - Bahia, Porto Seguro: Fazenda Batalha (03/2005),
   - Bahia, Pr. Tancredo Neves: Casa familiar Rural (06/2007),
   - Bahia, Igrapiuna: PMB (06/2000-06/2004)
   - Espirito Santo, Pinheiros (04/2007)
2. Other America's Countries:
   - Ecuador : 2 trials (02/2006 & 01/2007)
   - Colombia: 1 trial (07/2007)
   - (Guatemala)
   - (Peru)

Large Scale Clonal Trial in Bahia-Brazil

FX 3864

CDC 312

FDR 5788

Fisher block design:
8-10 clones (treatments)
4 replicates
80 trees/clone/replicate

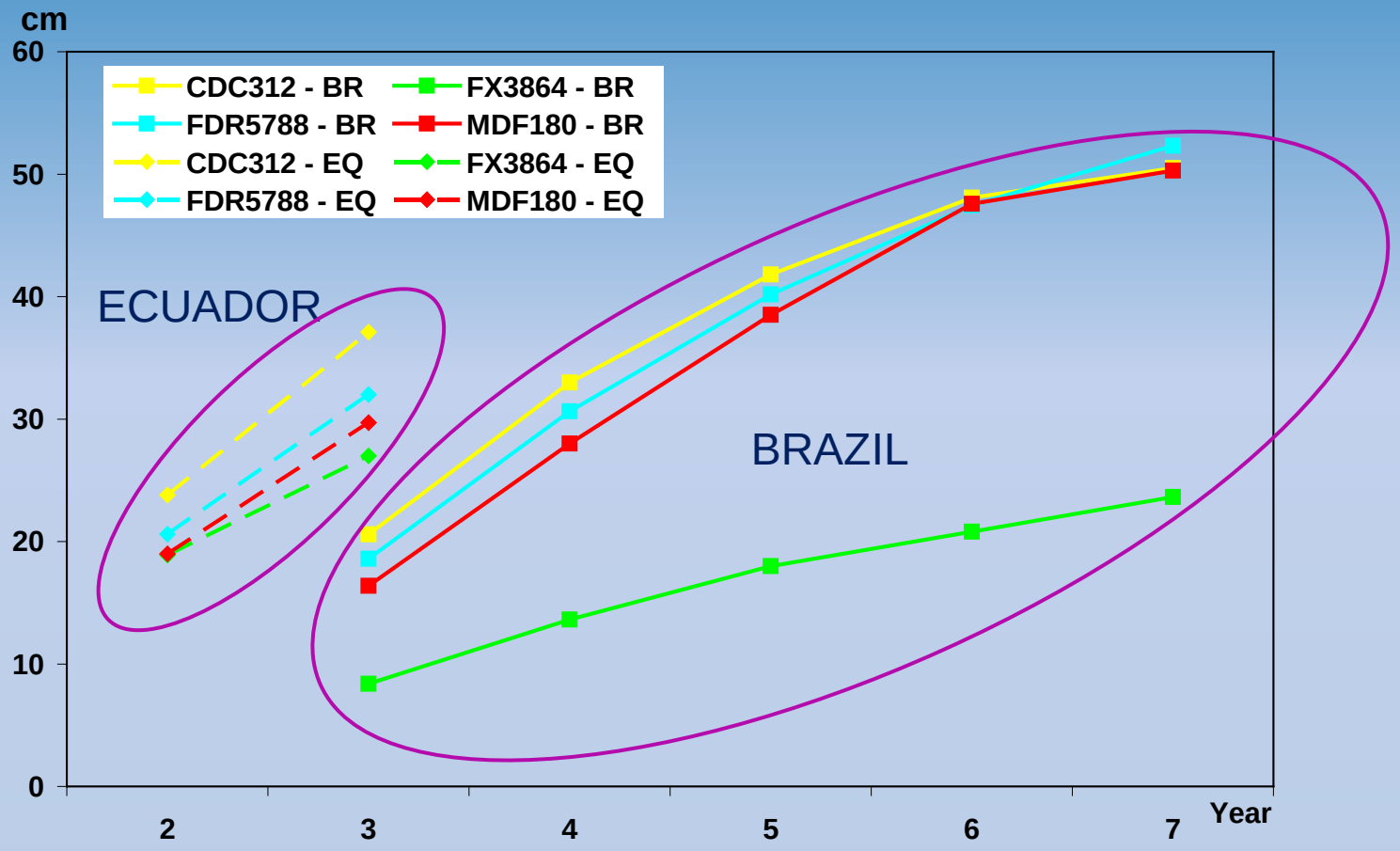
3 years LSCT in Santo Domingo, Ecuador

SALB Resistance of CMS clones in Latin America's network

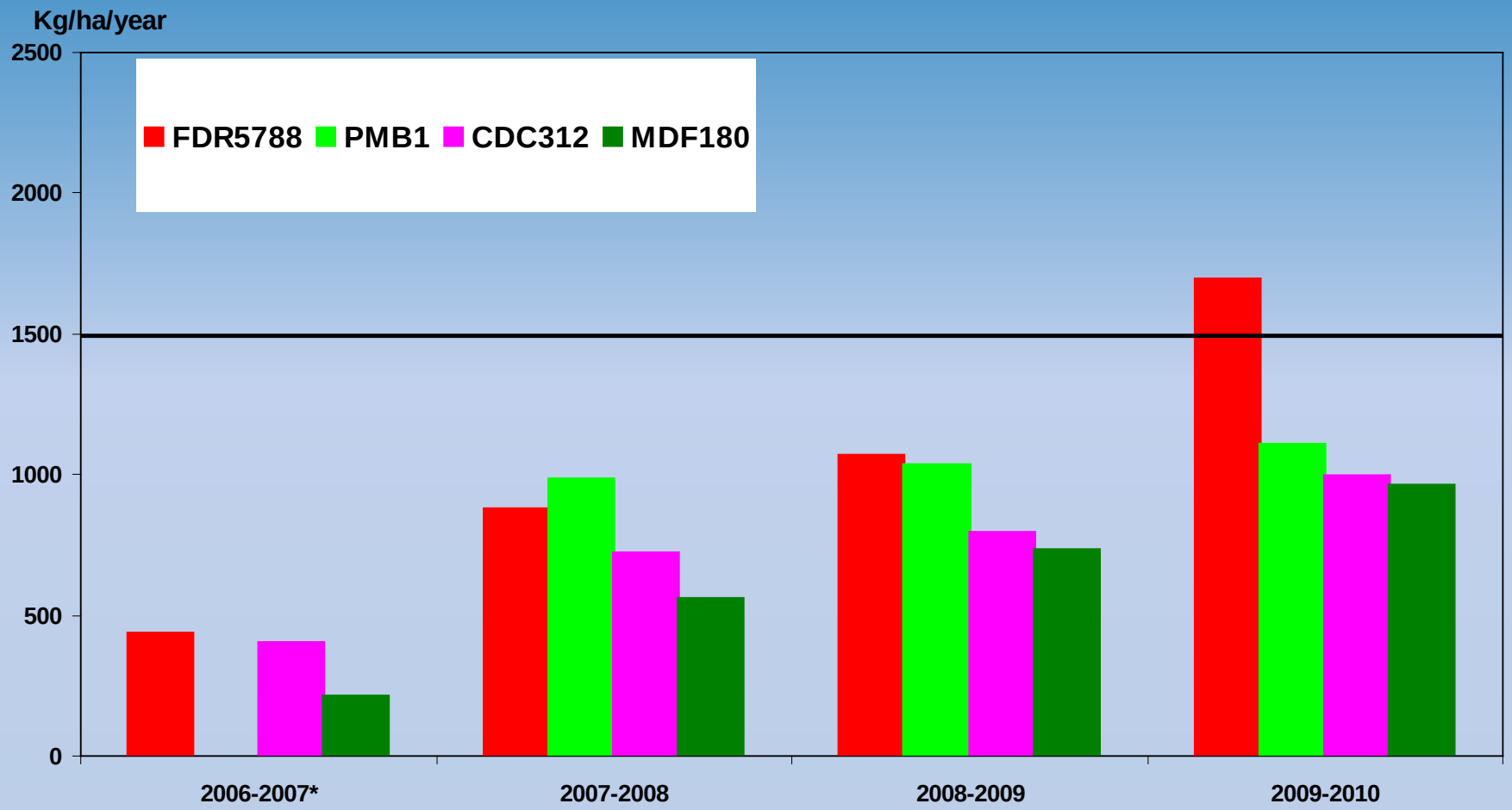
Clones	ECUADOR	BRAZIL
CDC 312	HR	R
FDR 5788	R	R
CDC 56	HR	R
MDF 180	HR	R
FDR 5597	HR	R
FX 3864	S	HS
FX 4098	S	HS

HR: Highly Resistant; R: Resistant; S: Susceptible; HS: Highly susceptible
FX 3864: control

Annual circumference of CMS clones in Ecuador and Brazil



Production of CMS clones in LSCT, in Bahia-Brazil (dry rubber)



International network of 13 CMS Clones 2/2

3. Quarantine was done in Montpellier France in 2005, before sending to:

- Africa: Ghana (2007)
- Asia: Malaysia (2008) and Cambodia (2009)

-> Objective:

- To assess this material regarding production and disease resistance (Corynespora, Oïdium, etc) in traditional areas of culture, without SALB,
- To provide an alternative in case of introduction of *Microcyclus ulei*.

Quarantine station in Montpellier - France

Objective: Transfer and Evaluate 13 CMB Resistant Clones in Asia and Africa

CD 1174	FDR 4575
CDC 56	FDR 5240
CDC 312	FDR 5283
MDX 607	FDR 5597
MDX 624	FDR 5665
PMB 1	FDR 5788
	FDR 5802

Conclusions

- CMB breeding program is today the only program offering a sustainable alternative to SALB risk.
- The high number of progenies and the large genetic diversity of the genitors provide interesting materials to be selected for **SALB resistance, production** and **adaptation to sub-optimal areas.**
- An **international network of trials** for testing new genotypes, respecting international quarantine orientations, is essential to offer new clonal alternatives for rubber development in **high-SALB and low-SALB** areas, and possibly in case of SALB introduction in the other continents.


Thank you for your attention!